

## Final datasheet

### XHP™2 module with CoolSiC™ Trench MOSFET

#### Features

- Electrical features
  - $V_{DSS} = 3300\text{ V}$
  - $I_{DN} = 1000\text{ A} / I_{DRM} = 2000\text{ A}$
  - $T_{vj,op} = 175^{\circ}\text{C}$
  - Low switching losses
  - High current density
  - Low inductive design
- Mechanical features
  - High power density
  - Package with CTI > 600
  - High creepage and clearance distances
  - AlSiC base plate for increased thermal cycling capability
  - AlN substrate with low thermal resistance



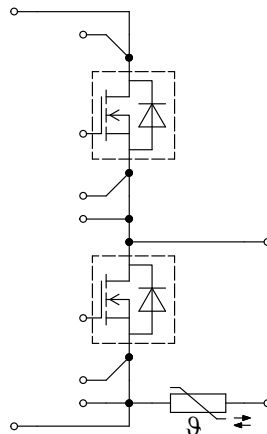
#### Potential applications

- Traction drives
- High-power converters
- High-frequency switching application

#### Product validation

- Qualified for industrial applications according to the relevant tests of IEC 60747, 60749 and 60068

#### Description



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## 1 Package

**Table 1** Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	$V_{ISOL}$	RMS, $f = 50 \text{ Hz}$ , $t = 1 \text{ min}$	6.0	kV
Partial discharge extinction voltage	$V_{isol}$	RMS, $f = 50 \text{ Hz}$ , $Q_{PD} \leq 10 \text{ pC}$	2.6	kV
DC stability	$V_{CE(D)}$	$T_{vj} = 25 \text{ °C}$ , 100 Fit	2100	V
Material of module baseplate			AlSiC	
Creepage distance	$d_{Creep \text{ nom}}$	terminal to baseplate, nom.	40.0	mm
Creepage distance	$d_{Creep \text{ nom}}$	terminal to terminal, nom.	34.0	mm
Clearance	$d_{Clear \text{ nom}}$	terminal to baseplate, nom.	31.0	mm
Clearance	$d_{Clear \text{ nom}}$	terminal to terminal, nom.	8.0	mm
Comparative tracking index	$CTI$		> 600	

**Table 2** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Stray inductance module	$L_{SCE}$			10		nH	
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25 \text{ °C}$ , per switch		0.43		mΩ	
Storage temperature	$T_{stg}$		-40		150	°C	
Maximum baseplate operation temperature	$T_{BPmax}$				150	°C	
Mounting torque for module mounting	$M$	- Mounting according to valid application note	M6, Screw	4.25		5.75	Nm
Terminal connection torque	$M$	- Mounting according to valid application note	M3, Screw	0.9		1.1	Nm
			M8, Screw	8		10	
Weight	$G$			720		g	

## 2 MOSFET

**Table 3** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Drain-source voltage	$V_{DSS}$	$T_{vj} = 25 \text{ °C}$	3300	V
Implemented drain current	$I_{DN}$		1000	A
Continuous DC drain current	$I_{DDC}$	$T_{vj} = 175 \text{ °C}$ , $V_{GS} = 15 \text{ V}$ $T_C = 25 \text{ °C}$	925	A

(table continues...)

**Table 3 (continued) Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit
Repetitive peak drain current	$I_{DRM}$	verified by design, $t_p$ limited by $T_{vjmax}$	2000	A
Gate-source voltage, max. transient voltage	$V_{GS}$	$D < 0.01$	-10/23	V
Gate-source voltage, max. static voltage	$V_{GS}$		-7/20	V

**Table 4 Recommended values**

Parameter	Symbol	Note or test condition	Values	Unit
On-state gate voltage	$V_{GS(on)}$		15...18	V
Off-state gate voltage	$V_{GS(off)}$		-5	V

**Table 5 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Drain-source on-resistance	$R_{DS(on)}$	$I_D = 1000\text{ A}$	$V_{GS} = 15\text{ V}, T_{vj} = 25\text{ °C}$	1.9	2.4	mΩ
			$V_{GS} = 15\text{ V}, T_{vj} = 125\text{ °C}$	3.7	4.6	
			$V_{GS} = 15\text{ V}, T_{vj} = 175\text{ °C}$	5.3	6.6	
Gate threshold voltage	$V_{GS(th)}$	$I_D = 900\text{ mA}, V_{DS} = V_{GS}, T_{vj} = 25\text{ °C},$ (tested after 1ms pulse at $V_{GS} = +20\text{ V}$ )	3.45	4.3	5.55	V
Total gate charge	$Q_G$	$V_{DD} = 1800\text{ V}, V_{GS} = -5/15\text{ V}$		5		μC
Internal gate resistor	$R_{Gint}$	$T_{vj} = 25\text{ °C}$		0.75		Ω
Input capacitance	$C_{ISS}$	$f = 100\text{ kHz}, V_{DS} = 1800\text{ V}, V_{GS} = 0\text{ V}, T_{vj} = 25\text{ °C}$		203		nF
Output capacitance	$C_{OSS}$	$f = 100\text{ kHz}, V_{DS} = 1800\text{ V}, V_{GS} = 0\text{ V}, T_{vj} = 25\text{ °C}$		2.8		nF
Reverse transfer capacitance	$C_{rSS}$	$f = 100\text{ kHz}, V_{DS} = 1800\text{ V}, V_{GS} = 0\text{ V}, T_{vj} = 25\text{ °C}$		0.115		nF
$C_{OSS}$ stored energy	$E_{OSS}$	$V_{DS} = 1800\text{ V}, V_{GS} = -5/15\text{ V}, T_{vj} = 25\text{ °C}$		5.8		mJ
Drain-source leakage current	$I_{DSS}$	$V_{DS} = 3300\text{ V}, V_{GS} = -5\text{ V}, T_{vj} = 25\text{ °C}$			2000	μA
Gate-source leakage current	$I_{GSS}$	$V_{DS} = 0\text{ V}, T_{vj} = 25\text{ °C}, V_{GS} = 20\text{ V}$			10000	nA

**(table continues...)**

**Table 5 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on delay time (inductive load)	$t_{d\ on}$	$I_D = 1000\ A$ , $R_{Gon} = 0.75\ \Omega$ , $V_{DD} = 1800\ V$ , $V_{GS} = -5/15\ V$	$T_{vj} = 25\ ^\circ C$	480		ns
			$T_{vj} = 125\ ^\circ C$	420		
			$T_{vj} = 175\ ^\circ C$	420		
Rise time (inductive load)	$t_r$	$I_D = 1000\ A$ , $R_{Gon} = 0.75\ \Omega$ , $V_{DD} = 1800\ V$ , $V_{GS} = -5/15\ V$	$T_{vj} = 25\ ^\circ C$	170		ns
			$T_{vj} = 125\ ^\circ C$	210		
			$T_{vj} = 175\ ^\circ C$	210		
Turn-off delay time (inductive load)	$t_{d\ off}$	$I_D = 1000\ A$ , $R_{Goff} = 1.2\ \Omega$ , $V_{DD} = 1800\ V$ , $V_{GS} = -5/15\ V$	$T_{vj} = 25\ ^\circ C$	330		ns
			$T_{vj} = 125\ ^\circ C$	370		
			$T_{vj} = 175\ ^\circ C$	380		
Fall time (inductive load)	$t_f$	$I_D = 1000\ A$ , $R_{Goff} = 1.2\ \Omega$ , $V_{DD} = 1800\ V$ , $V_{GS} = -5/15\ V$	$T_{vj} = 25\ ^\circ C$	82		ns
			$T_{vj} = 125\ ^\circ C$	82		
			$T_{vj} = 175\ ^\circ C$	82		
Turn-on time (resistive load)	$t_{on\_R}$	$I_D = 500\ A$ , $V_{DD} = 2000\ V$ , $V_{GS} = -5/15\ V$ , $R_{Gon} = 0.75\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.50		$\mu s$
Turn-on energy loss per pulse	$E_{on}$	$I_D = 1000\ A$ , $V_{DD} = 1800\ V$ , $L_\sigma = 30\ nH$ , $V_{GS} = -5/15\ V$ , $R_{Gon} = 0.75\ \Omega$ , $di/dt = 7.8\ kA/\mu s$ ( $T_{vj} = 175\ ^\circ C$ )	$T_{vj} = 25\ ^\circ C$	280		mJ
			$T_{vj} = 125\ ^\circ C$	350		
			$T_{vj} = 175\ ^\circ C$	420		
Turn-off energy loss per pulse	$E_{off}$	$I_D = 1000\ A$ , $V_{DD} = 1800\ V$ , $L_\sigma = 30\ nH$ , $V_{GS} = -5/15\ V$ , $R_{Goff} = 1.2\ \Omega$ , $dv/dt = 18.2\ kV/\mu s$ ( $T_{vj} = 175\ ^\circ C$ )	$T_{vj} = 25\ ^\circ C$	160		mJ
			$T_{vj} = 125\ ^\circ C$	160		
			$T_{vj} = 175\ ^\circ C$	160		
SC data	$I_{SC}$	$V_{GS} = -5/15\ V$ , $V_{DD} = 2400\ V$ , $V_{DSmax} = V_{DSS} - L_{sDS} * di/dt$ , $R_G = 0.75\ \Omega$	$t_p = 3\ \mu s$ , $T_{vj} = 175\ ^\circ C$	9100		A
Thermal resistance, junction to case	$R_{thJC}$	per MOSFET			26.3	K/kW
Thermal resistance, case to heat sink	$R_{thCH}$	per MOSFET, $\lambda_{grease} = 1\ W/(m^*K)$		21.5		K/kW
Temperature under switching conditions	$T_{vj\ op}$		-40		175	$^\circ C$

### 3 Body diode (MOSFET)

**Table 6** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
DC body diode forward current	$I_{SD}$	$T_{vj} = 175\text{ °C}$ , $V_{GS} = -5\text{ V}$ $T_C = 55\text{ °C}$	1000	A
$I^2t$ - value	$I^2t$	$V_{DS} = 0\text{ V}$ , $V_{GS} = -5\text{ V}$ , $t_P = 10\text{ ms}$ $T_{vj} = 175\text{ °C}$	500	$\text{kA}^2\text{s}$

**Table 7** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	$V_{SD}$	$I_{SD} = 1000\text{ A}$ , $V_{GS} = -5\text{ V}$	$T_{vj} = 25\text{ °C}$	4.6	5.8	V
			$T_{vj} = 125\text{ °C}$	3.9	4.9	
			$T_{vj} = 175\text{ °C}$	3.6	4.5	
Reverse recovery energy	$E_{rec}$	$I_{SD} = 1000\text{ A}$ , $di_s/dt = 7.8\text{ kA}/\mu\text{s}$ ( $T_{vj} = 175\text{ °C}$ ), $V_{DD} = 1800\text{ V}$ , $V_{GS} = -5\text{ V}$	$T_{vj} = 25\text{ °C}$	40		mJ
			$T_{vj} = 125\text{ °C}$	62		
			$T_{vj} = 175\text{ °C}$	105		

### 4 NTC-Thermistor

**Table 8** Characteristic values

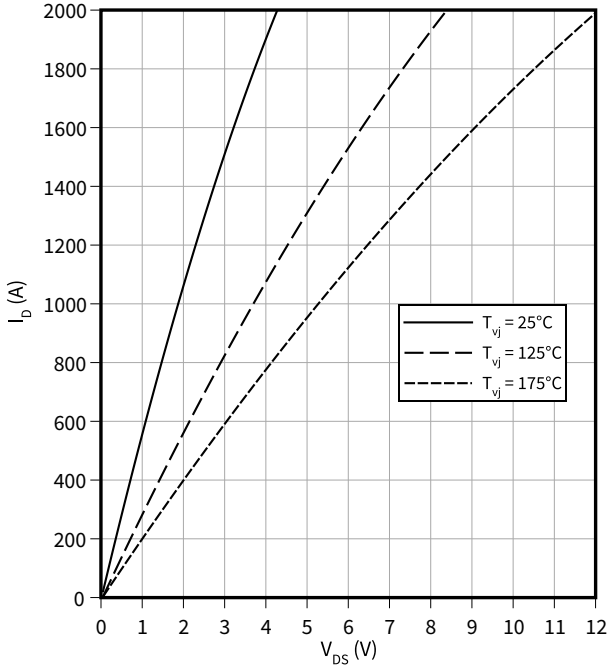
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	$R_{25}$	$T_{NTC} = 25\text{ °C}$		5		k $\Omega$
Deviation of $R_{100}$	$\Delta R/R$	$T_{NTC} = 100\text{ °C}$ , $R_{100} = 493\text{ }\Omega$	-5		5	%
Power dissipation	$P_{25}$	$T_{NTC} = 25\text{ °C}$			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298,15\text{ K}))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298,15\text{ K}))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298,15\text{ K}))]$		3433		K

**Note:** Specification according to the valid application note.

**5 Characteristics diagrams**

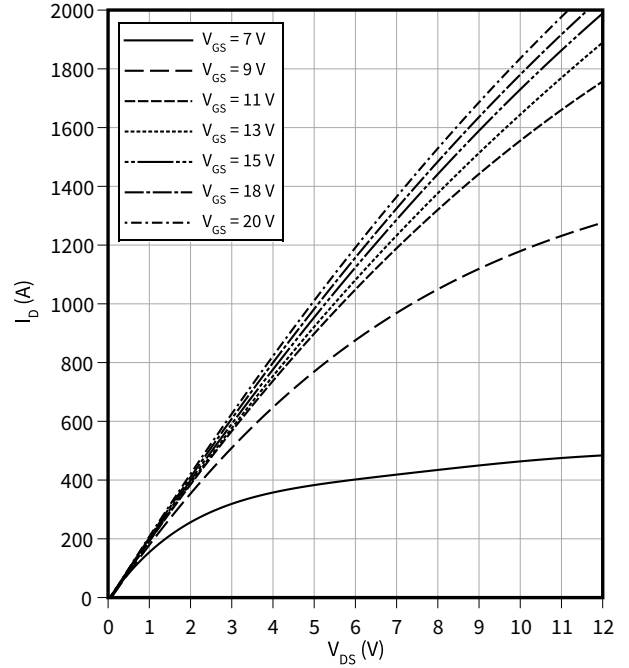
**Output characteristic (typical), MOSFET**

$I_D = f(V_{DS})$   
 $V_{GS} = 15\text{ V}$



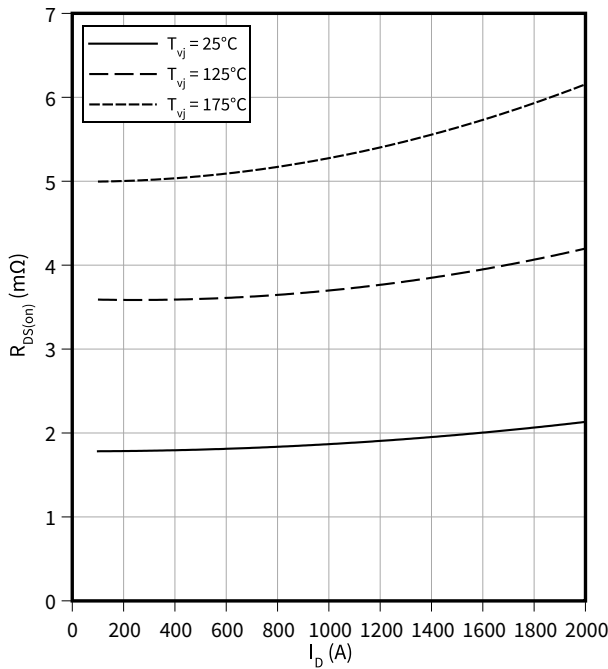
**Output characteristic field (typical), MOSFET**

$I_D = f(V_{DS})$   
 $T_{vj} = 175\text{ °C}$



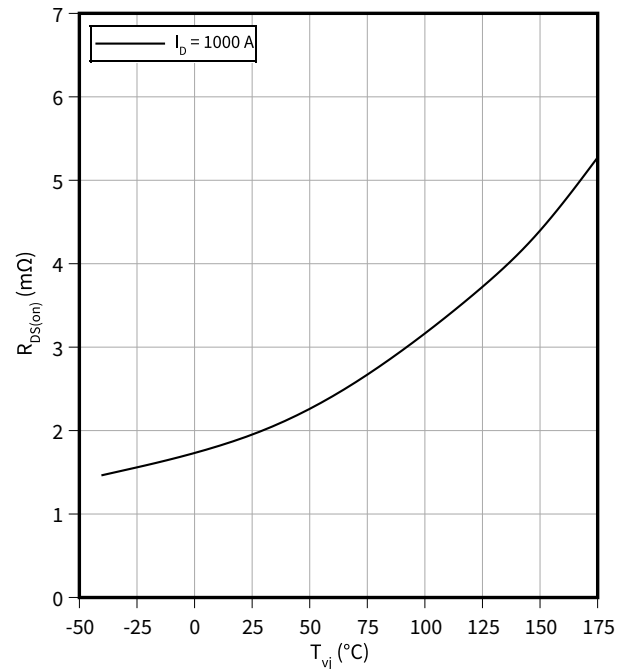
**Drain source on-resistance (typical), MOSFET**

$R_{DS(on)} = f(I_D)$   
 $V_{GS} = 15\text{ V}$



**Drain source on-resistance (typical), MOSFET**

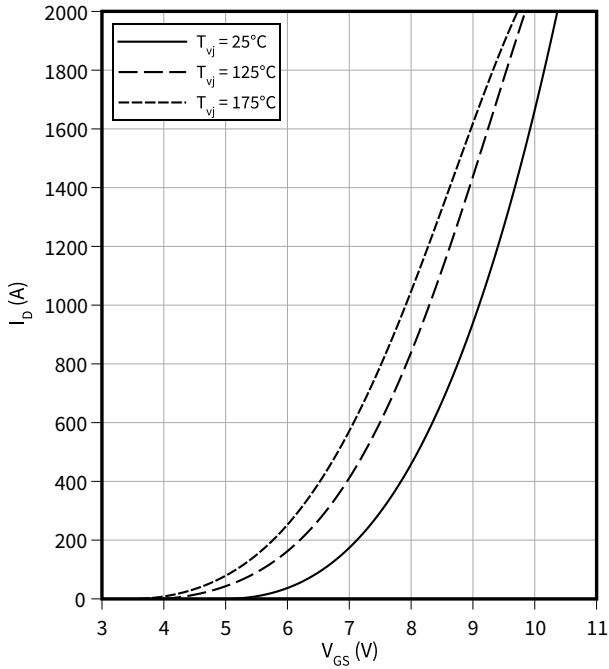
$R_{DS(on)} = f(T_{vj})$   
 $V_{GS} = 15\text{ V}$



**5 Characteristics diagrams**

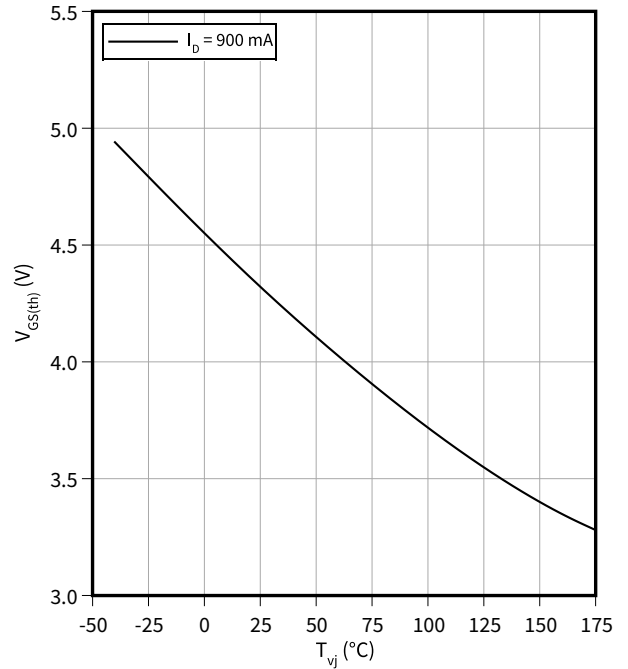
**Transfer characteristic (typical), MOSFET**

$I_D = f(V_{GS})$   
 $V_{DS} = 20\text{ V}$



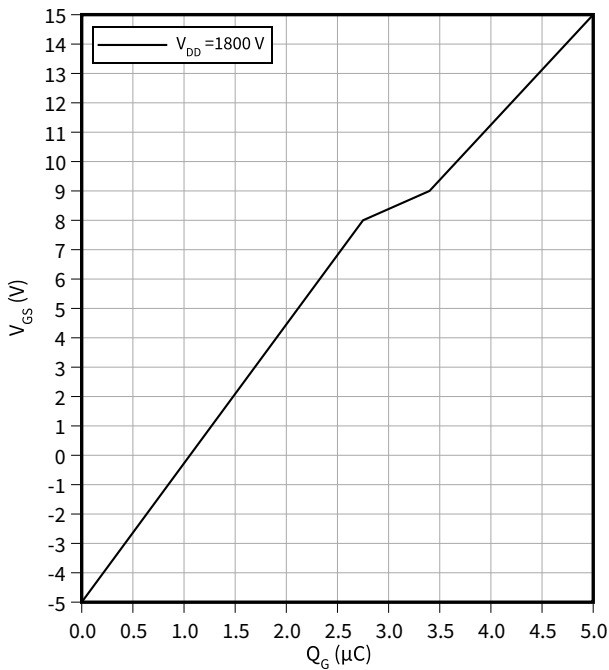
**Gate-source threshold voltage (typical), MOSFET**

$V_{GS(th)} = f(T_{vj})$   
 $V_{GS} = V_{DS}$



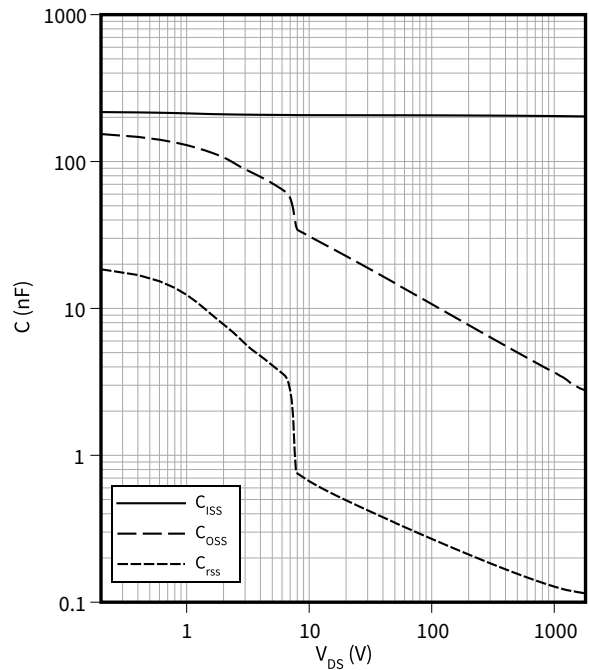
**Gate charge characteristic (typical), MOSFET**

$V_{GS} = f(Q_G)$   
 $I_D = 1000\text{ A}, T_{vj} = 25^\circ\text{C}$



**Capacity characteristic (typical), MOSFET**

$C = f(V_{DS})$   
 $f = 100\text{ kHz}, T_{vj} = 25^\circ\text{C}, V_{GS} = 0\text{ V}$



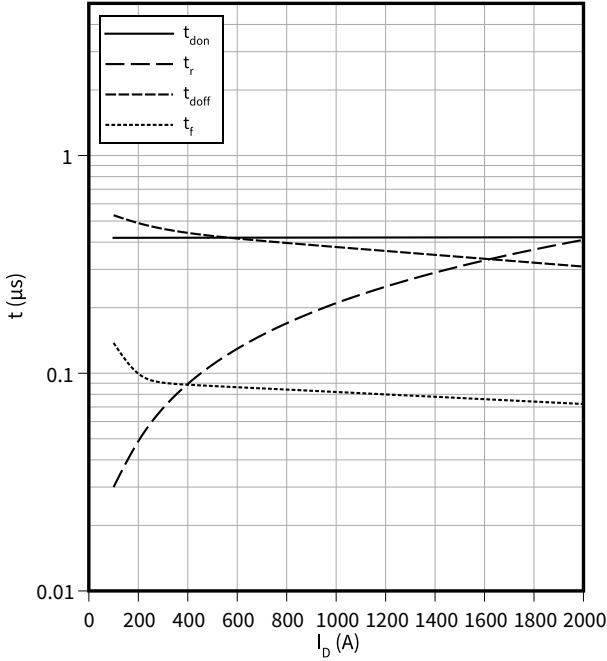


**5 Characteristics diagrams**

**Switching times (typical), MOSFET**

$t = f(I_D)$

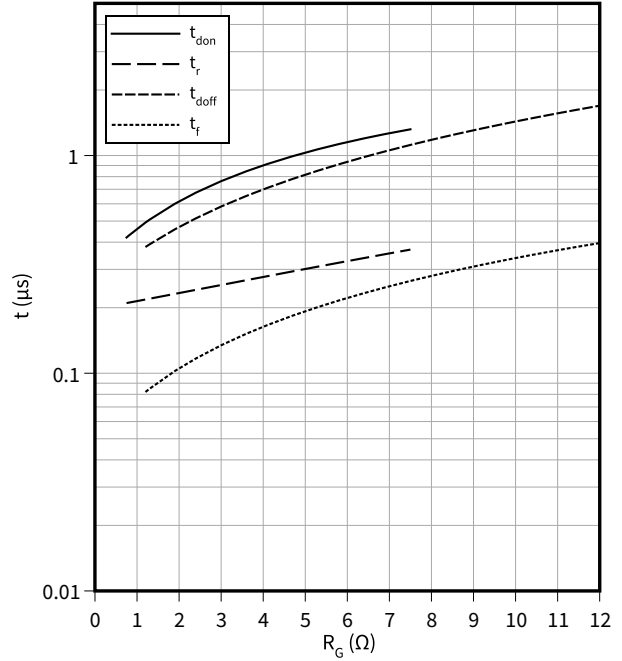
$R_{Goff} = 1.2 \Omega$ ,  $R_{Gon} = 0.75 \Omega$ ,  $V_{DD} = 1800 \text{ V}$ ,  $T_{vj} = 175 \text{ }^\circ\text{C}$ ,  $V_{GS} = -5/15 \text{ V}$



**Switching times (typical), MOSFET**

$t = f(R_G)$

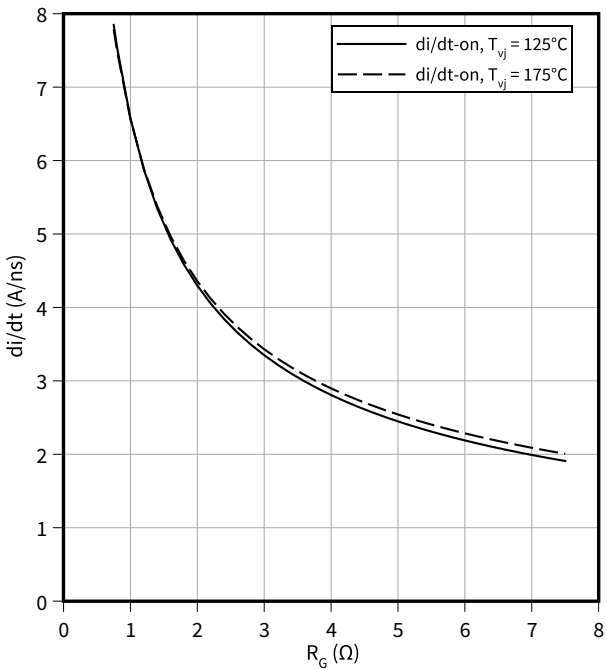
$V_{DD} = 1800 \text{ V}$ ,  $I_D = 1000 \text{ A}$ ,  $T_{vj} = 175 \text{ }^\circ\text{C}$ ,  $V_{GS} = -5/15 \text{ V}$



**Current slope (typical), MOSFET**

$di/dt = f(R_G)$

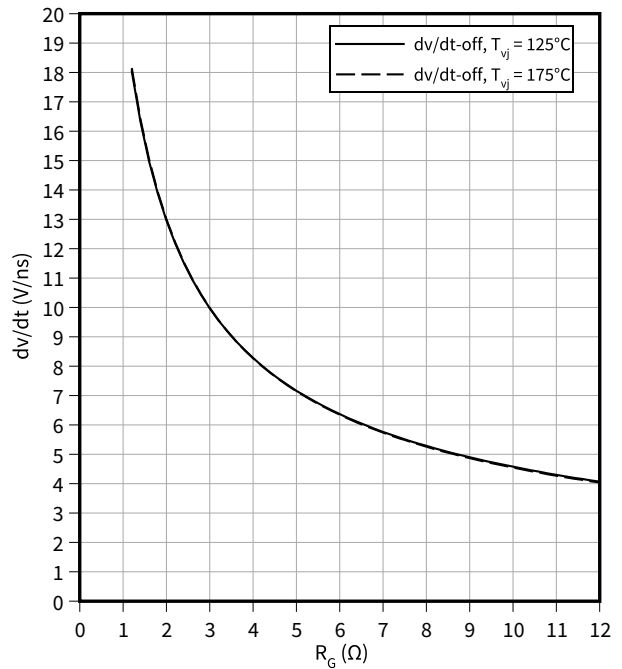
$V_{DD} = 1800 \text{ V}$ ,  $I_D = 1000 \text{ A}$ ,  $V_{GS} = -5/15 \text{ V}$



**Voltage slope (typical), MOSFET**

$dv/dt = f(R_G)$

$V_{DD} = 1800 \text{ V}$ ,  $I_D = 1000 \text{ A}$ ,  $V_{GS} = -5/15 \text{ V}$

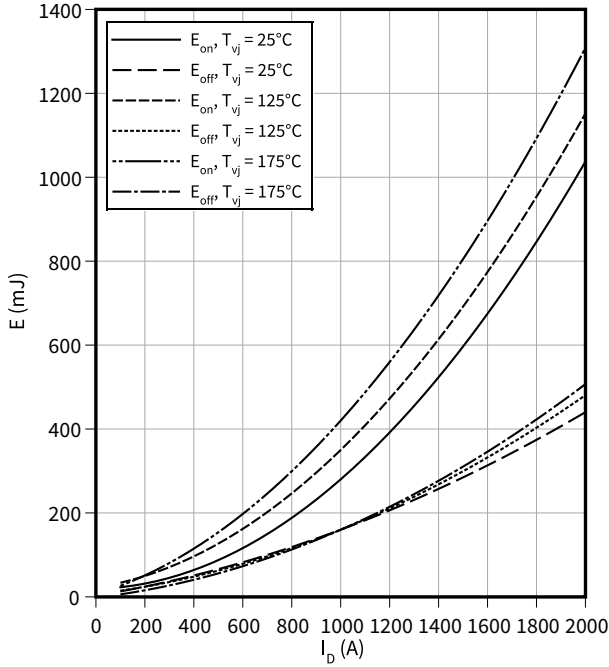


5 Characteristics diagrams

**Switching losses (typical), MOSFET**

$E = f(I_D)$

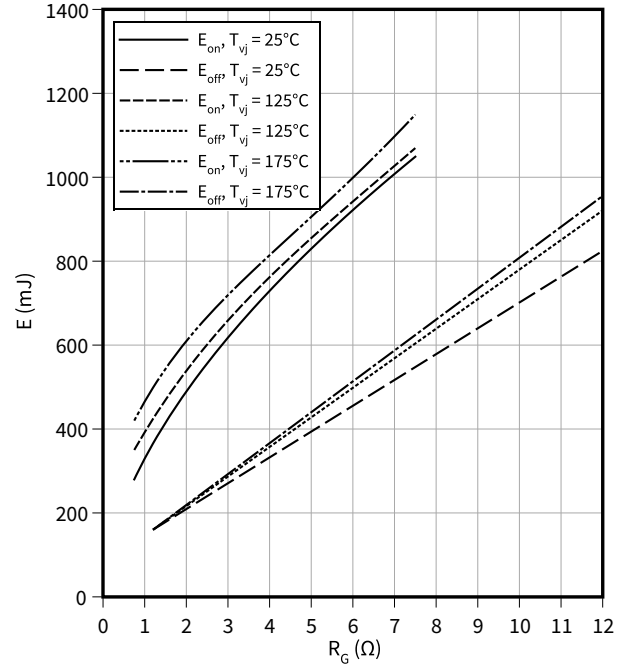
$R_{Goff} = 1.2 \Omega$ ,  $R_{Gon} = 0.75 \Omega$ ,  $V_{DD} = 1800 \text{ V}$ ,  $V_{GS} = -5/15 \text{ V}$



**Switching losses (typical), MOSFET**

$E = f(R_G)$

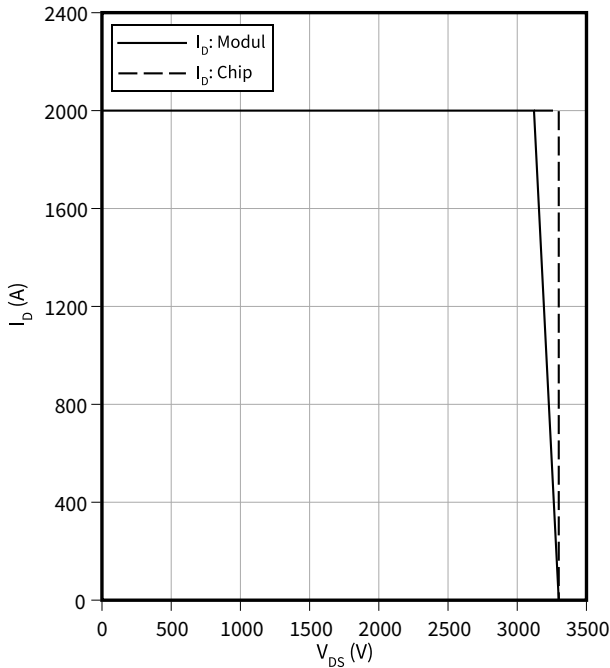
$V_{DD} = 1800 \text{ V}$ ,  $I_D = 1000 \text{ A}$ ,  $V_{GS} = -5/15 \text{ V}$



**Reverse bias safe operating area (RBSOA), MOSFET**

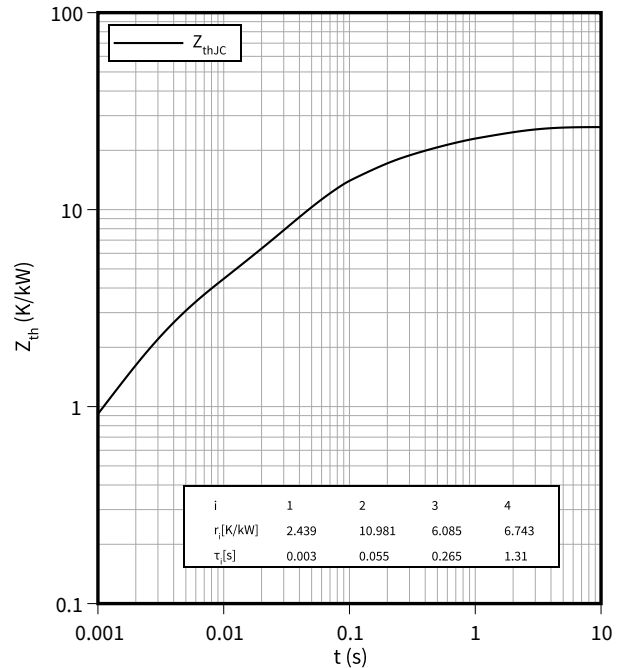
$I_D = f(V_{DS})$

$R_{Goff} = 1.2 \Omega$ ,  $T_{vj} = 175 \text{ }^\circ\text{C}$ ,  $V_{GS} = -5/15 \text{ V}$



**Transient thermal impedance, MOSFET**

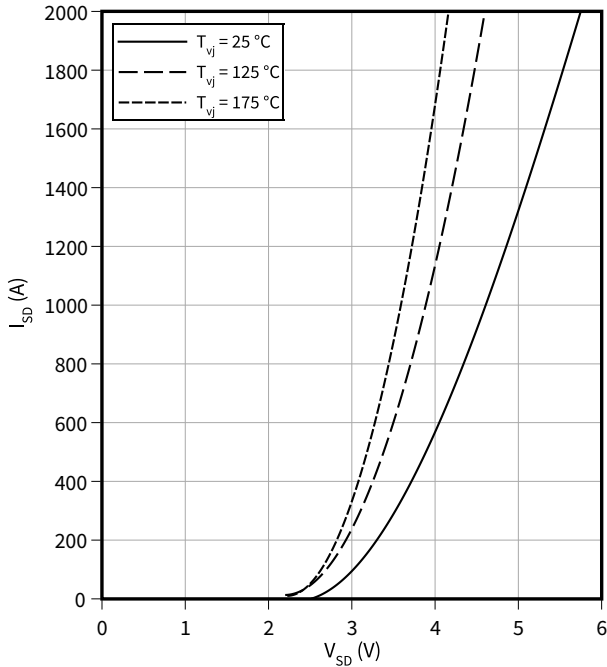
$Z_{th} = f(t)$



**5 Characteristics diagrams**

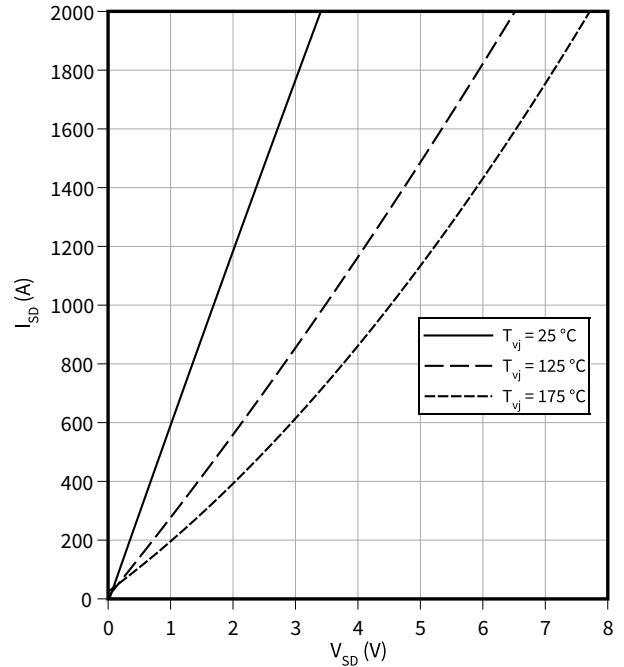
**Forward characteristic body diode (typical), MOSFET**

$I_{SD} = f(V_{SD})$   
 $V_{GS} = -5\text{ V}$



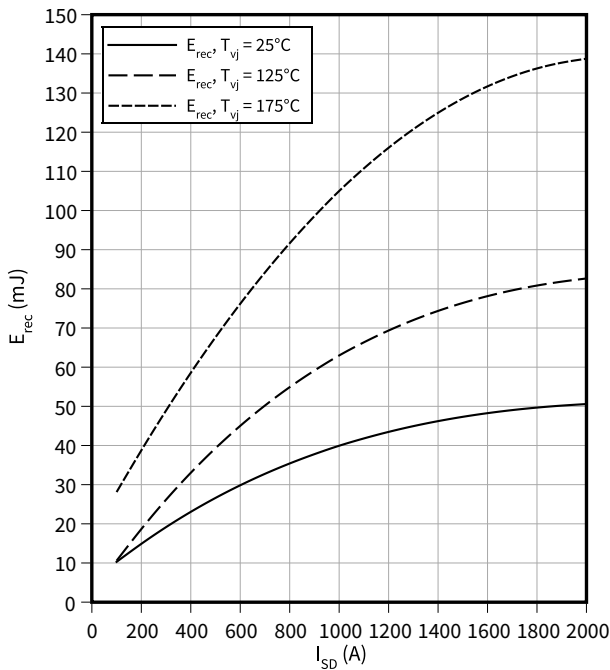
**Forward characteristic body diode (typical), MOSFET**

$I_{SD} = f(V_{SD})$   
 $V_{GS} = 15\text{ V}$



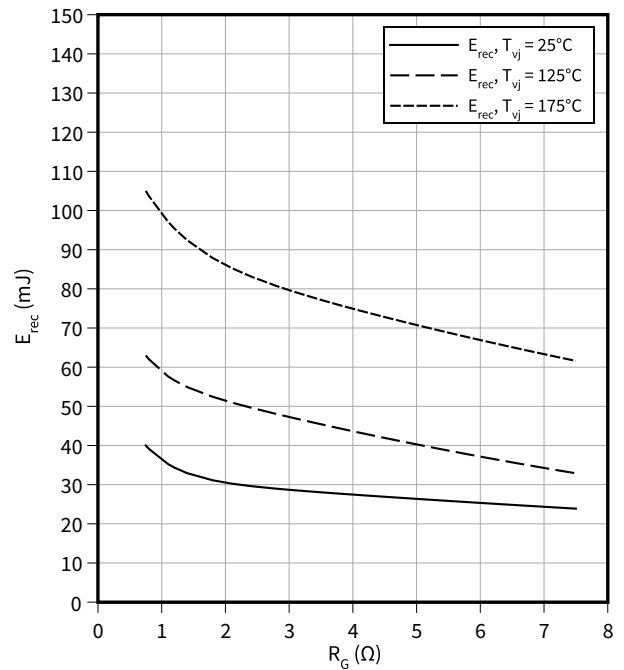
**Switching losses body diode (typical), MOSFET**

$E_{rec} = f(I_{SD})$   
 $R_{Gon} = 0.75\ \Omega, V_{DD} = 1800\text{ V}$



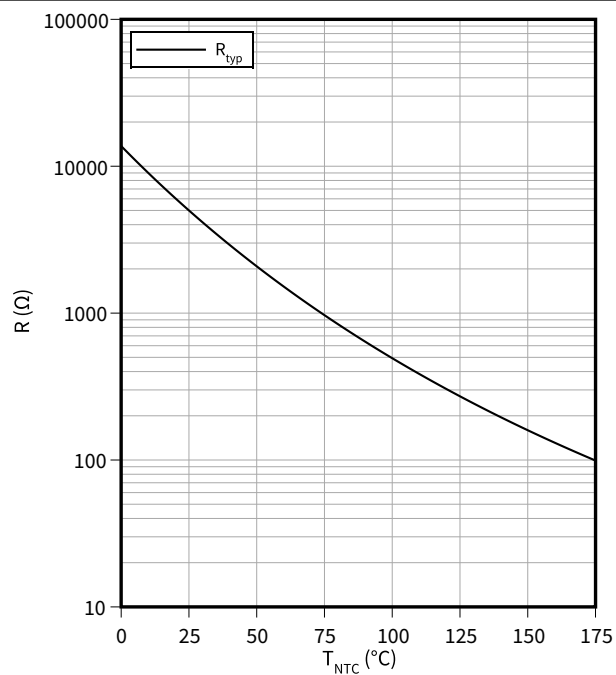
**Switching losses body diode (typical), MOSFET**

$E_{rec} = f(R_G)$   
 $V_{DD} = 1800\text{ V}, I_{SD} = 1000\text{ A}$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



## 6 Circuit diagram

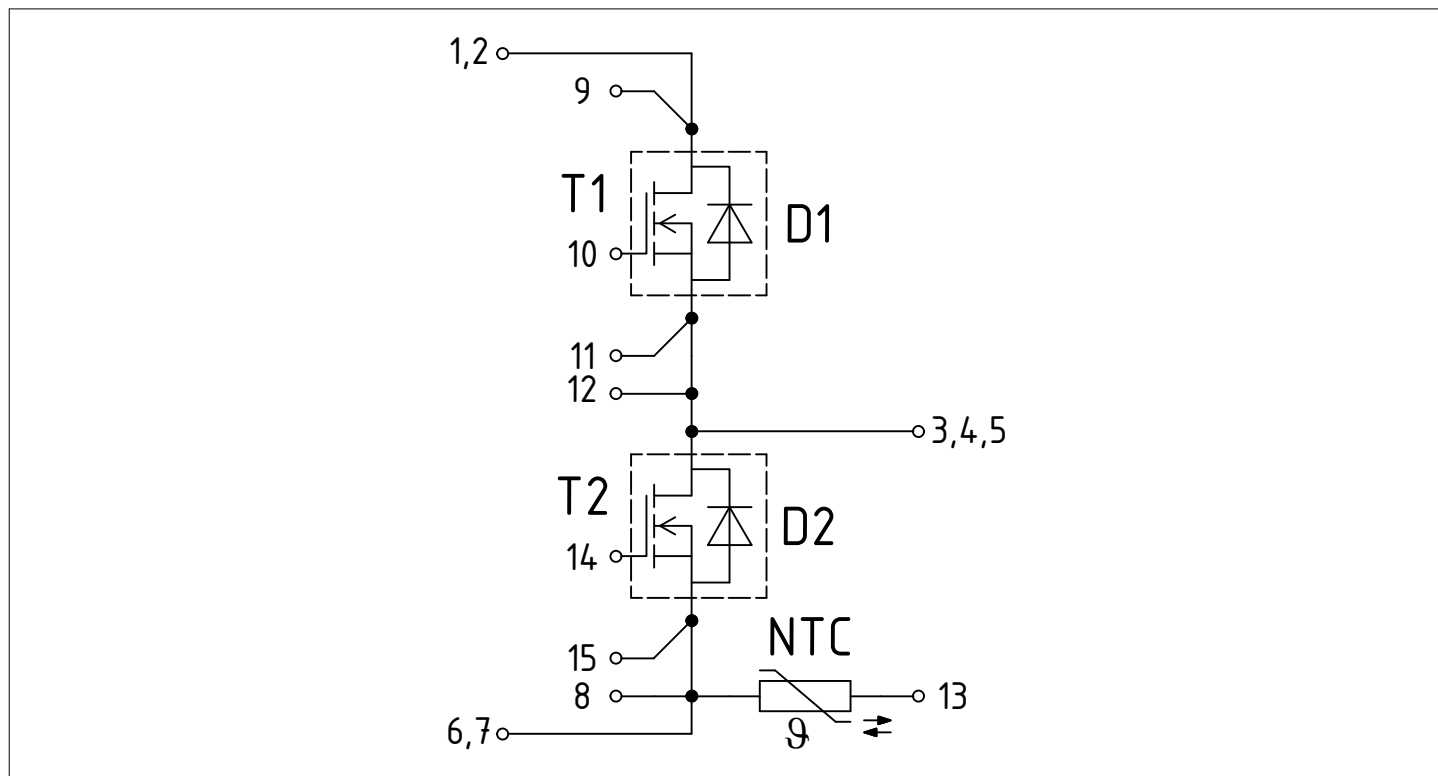


Figure 1

## 7 Package outlines

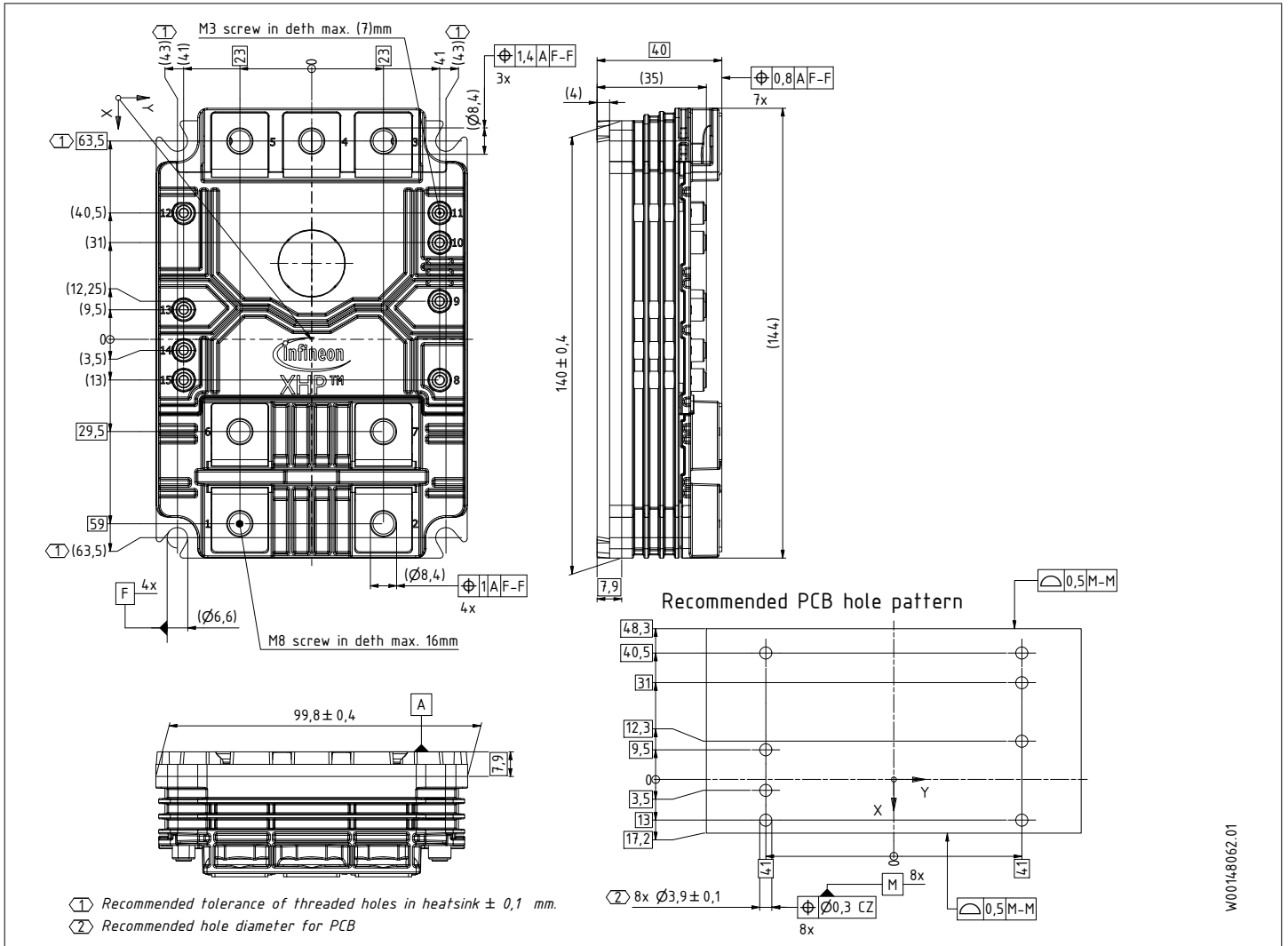


Figure 2

W00148062.01

## 8 Module label code


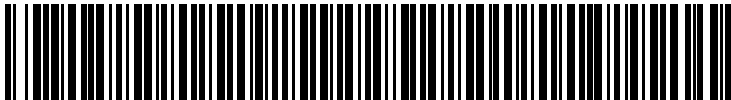
Module label code			
Code format	Data Matrix	Barcode Code128	
Encoding	ASCII text	Code Set A	
Symbol size	16x16	23 digits	
Standard	IEC24720 and IEC16022	IEC8859-1	
Code content	Content	Digit	Example
	Module serial number	1 - 5	71549
	Module material number	6 - 11	142846
	Production order number	12 - 19	55054991
	Date code (production year)	20 - 21	15
	Date code (production week)	22 - 23	30
Example	 		
	71549142846550549911530		71549142846550549911530

Figure 3

## Revision history

Document revision	Date of release	Description of changes
V1.0	2019-12-17	Target datasheet
n/a	2020-09-01	Datasheet migrated to a new system with a new layout and new revision number schema: target or preliminary datasheet = 0.xy; final datasheet = 1.xy
0.20	2023-11-21	Preliminary datasheet
1.00	2024-04-16	Final datasheet



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**IFX-AAY262-003**

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